TACTILE DISPLAY APPARATUS

BACKGROUND OF THE INVENTION

I. Field of the Invention

The present invention relates generally to tactile display apparatus, and, more particularly, to an electromechanical system for selectively displaying and erasing information from a reference surface.

II. Description of the Prior Art

A particularly desirable application for the invention concerns the presentation of the Braille character set for the blind. However, there are numerous other applications for the invention.

For example, a large matrix of tactile display units could be employed to display numbers, letters, and figures as raised patterns in devices that provide viewing screens for the blind. The sighted can also benefit from the invention. For example, tactile display units can be utilized singularly or in groups as displays on operating consoles for limited or low light conditions such as aircraft, mining equipment, and military hardware where the raised patterns can be utilized as nonvisual indicators.

Braille was devised to enable the blind to read alphanumeric characters and is in the form of a six unit code, where each cell represents a character or symbol. Thus, with a six unit code in each cell, there is a matrix of two columns with three in a column. By employing a six unit code, a maximum of sixty-four combinations can be created for which include the twenty-six letters of the alphabet, the numbers zero and one through nine, and various symbols such as case indicators, punctuation, and so forth.

A tactile display unit of the type which will be described in detail below is one which provides for the raising and lowering of a physical point above a plane of reference in such a manner that the change of state from one position to another, that is, from a raised position to a lowered position, or vice versa, is physically detectable by the sense of touch. Numerous mechanisms have been devised to provide such tactile displays. They have generally been large, complex, cumbersome, and expensive to construct, operate, and maintain. Many have been patented. Typical of patents which disclose such devices utilizing magnetically operable pins or solenoids are Nos. 3,395,247; 3,510,967; 3,592,965; 3,987,438; 4,033,053; 4,178,586; 4,191,945; and 4,194,190. Other typical patents disclose a variety of other mechanisms for achieving a similar result. For example, No. 2,891,324 discloses a mechanism which utilizes piano-like rolls; Nos. 4,044,350 and 4,473,356 disclose piezoelectric reeds; No. 4,586,904 discloses magnetically operable balls; No. 4,215,490 discloses mechanical linkages; No. 4,266,936 discloses bi-metallic latches; and Nos. 4,445,871 and 4,586,903 disclose the use of continuous belts. Because of their complexity, most of these known devices are expensive to manufacture, thereby resulting in an end product with a cost that is prohibitive to many consumers. Also, the power requirements of some of these devices require drive levels that are beyond the capability of most target units without the addition of a supplemental power supply.

SUMMARY OF THE INVENTION

It was with knowledge of the prior art as just described and with the goal of improving upon known technology that the present invention was conceived

and has now been reduced to practice. To this end, novel apparatus is disclosed for providing a tactile display according to which a touch pin is selectively movable relative to a reference surface. An electromagnet distant from the reference surface has spaced poles of opposite, selectively reversible, polarity. A cam rotatable about an axis transverse to the reference surface has an integral permanent magnet with similarly spaced poles of opposite polarity equidistant from the axis of rotation. The cam is rotatable between an active position at which its respective poles are attracted to and positioned adjacent the poles of the electromagnet and an inactive position at which the reversed poles of the permanent magnet are attracted to and positioned adjacent the opposite poles of the electromagnet. A touch pin has a longitudinal axis transverse to the reference surface and includes a follower end engageable with the cam and a tip end distant from the follower end. The pin is movable on the cam between a first position raised above the reference surface when the cam is in the active position and a second position not projecting beyond the reference surface when the cam is in the inactive position. A plurality of touch pins and associated mechanisms can be combined into a matrix to form a tactile display unit and a plurality of such units can be provided in a console and electrically driven in an intelligent fashion to provide the user with various forms of tactile information.

Depending on the desired application, the apparatus of the invention could be fabricated in a variety of sizes. In the instance of a Braille character display, for example, a size would be chosen that would allow a two-by-three matrix of tactile display devices to be packaged to provide a Braille character readout at the same scale as an embossed Braille text.

The apparatus described in this disclosure is operated by utilizing an induced electromagnetic force to rotate the cam about its longitudinal axis. The cam has a touch pin riding on a contoured surface. By rotating, the cam forces motion of the pin along its longitudinal axis which raises or lowers the pin. The contoured surface of the cam is so shaped that at its lowest position, the pin that rides on it is flush with the reference surface. At its highest point of travel, the pin is raised sufficiently to provide the user with a tactile point that is readily discernible from the lowered state.

The up and down motion of the touch pin is achieved by driving the cam with small positive and negative voltages, respectively. Simple decoding circuitry would assign positive voltages to a bit that is in the high (logical 1) state and a negative voltage to a bit that is in the low (logical 0) state. In the Braille example, a six bit data bus would be established to drive all six touch pins of a tactile display unit simultaneously.

These high and low signals would alternately supply positive and negative voltages to the electromagnet that is located below the cam. Embodied in the cam is a permanent magnet which would be repelled by the electromagnetic force. By the construction of the device, this action would force the cam to rotate about its axis to position the pin at the desired point. The high point of the contour on the cam would desirably have a small depression in which the pin can temporarily come to rest. Due to its design, the lower portion of the cam does not require an additional depression. Under the bias of a spring on the pin, the cam as well as the pin remain mutually in their desired positions until an oppo-